Testing VLPCs for the Neutron EDM Experiment

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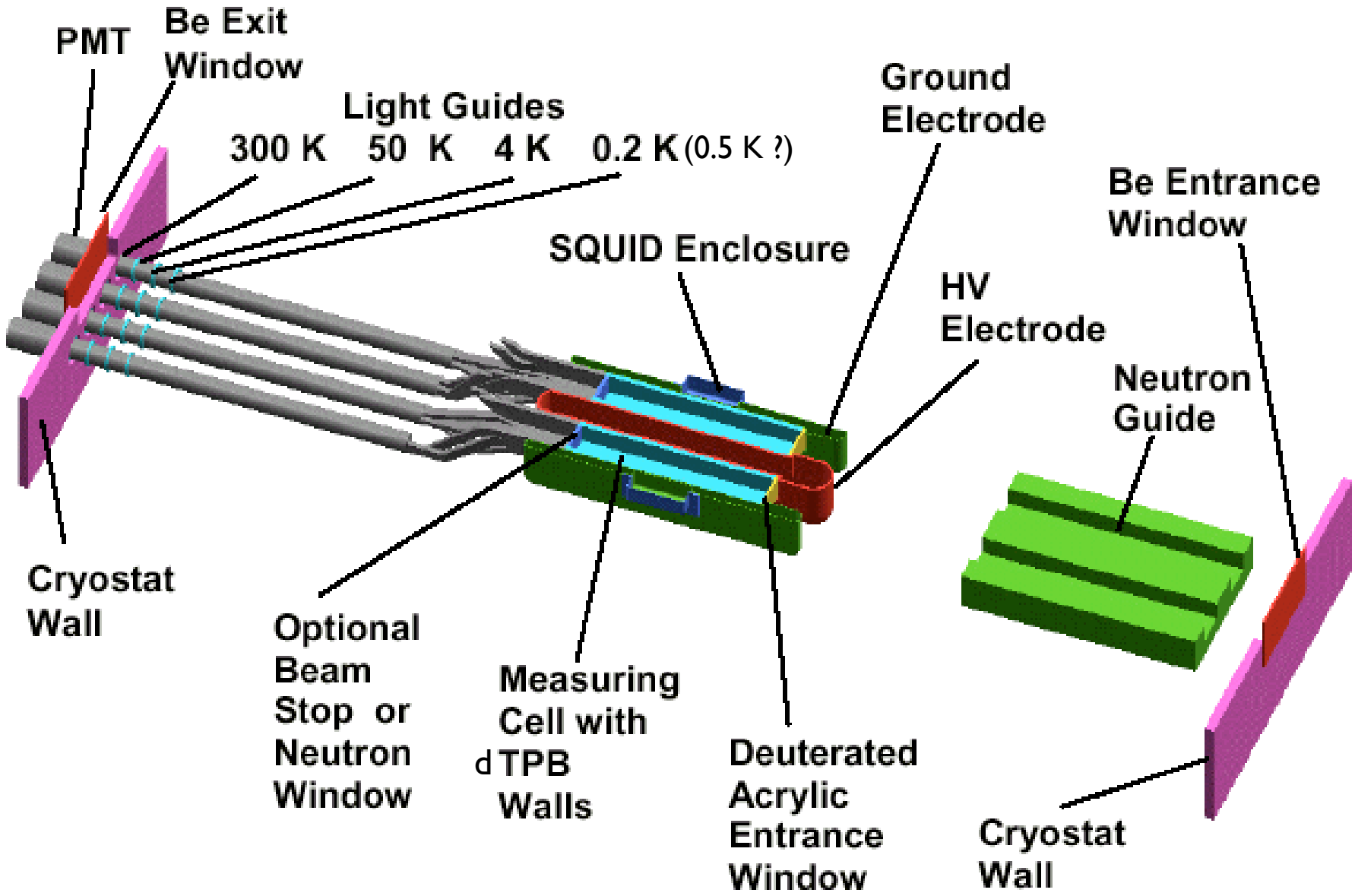
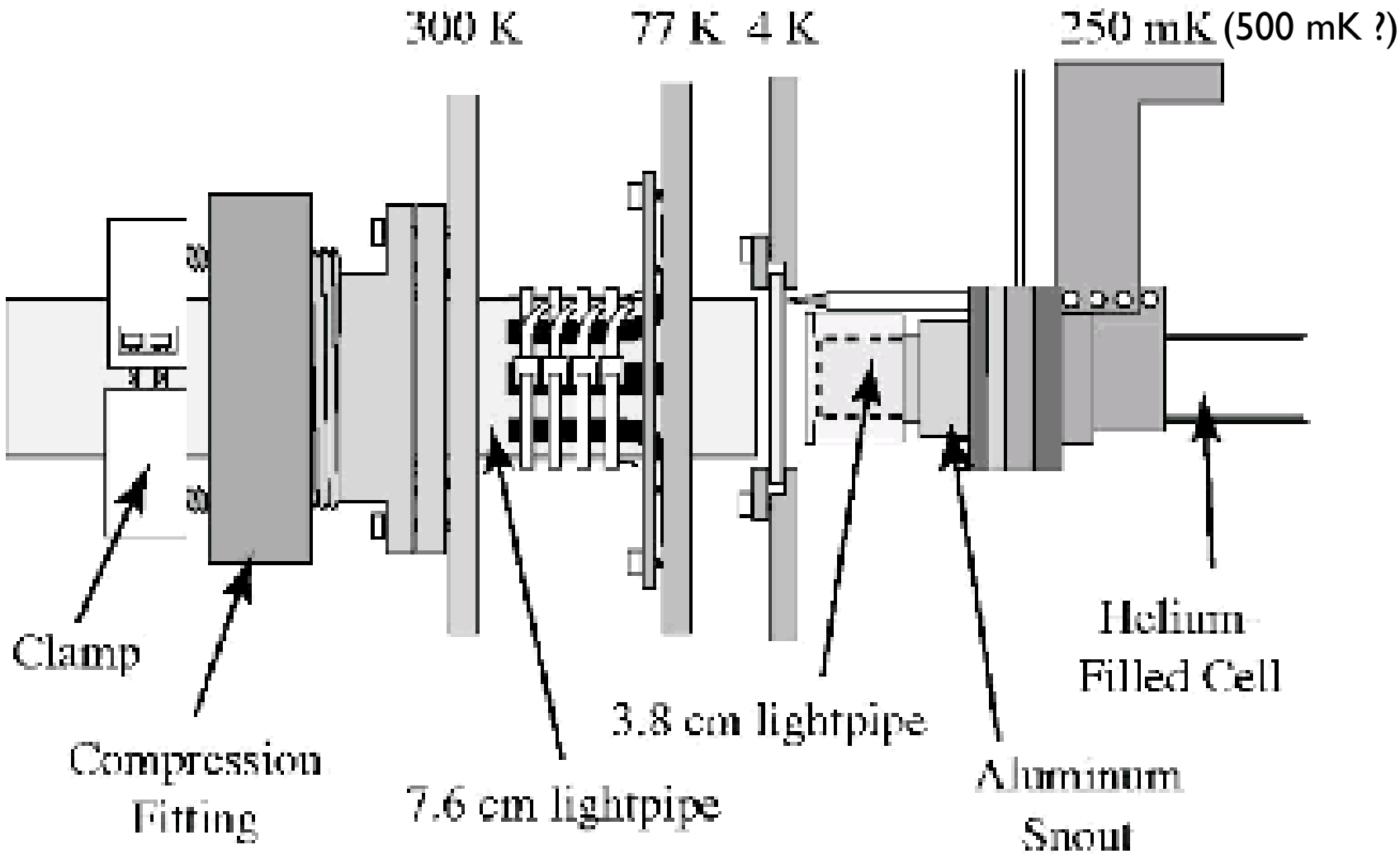
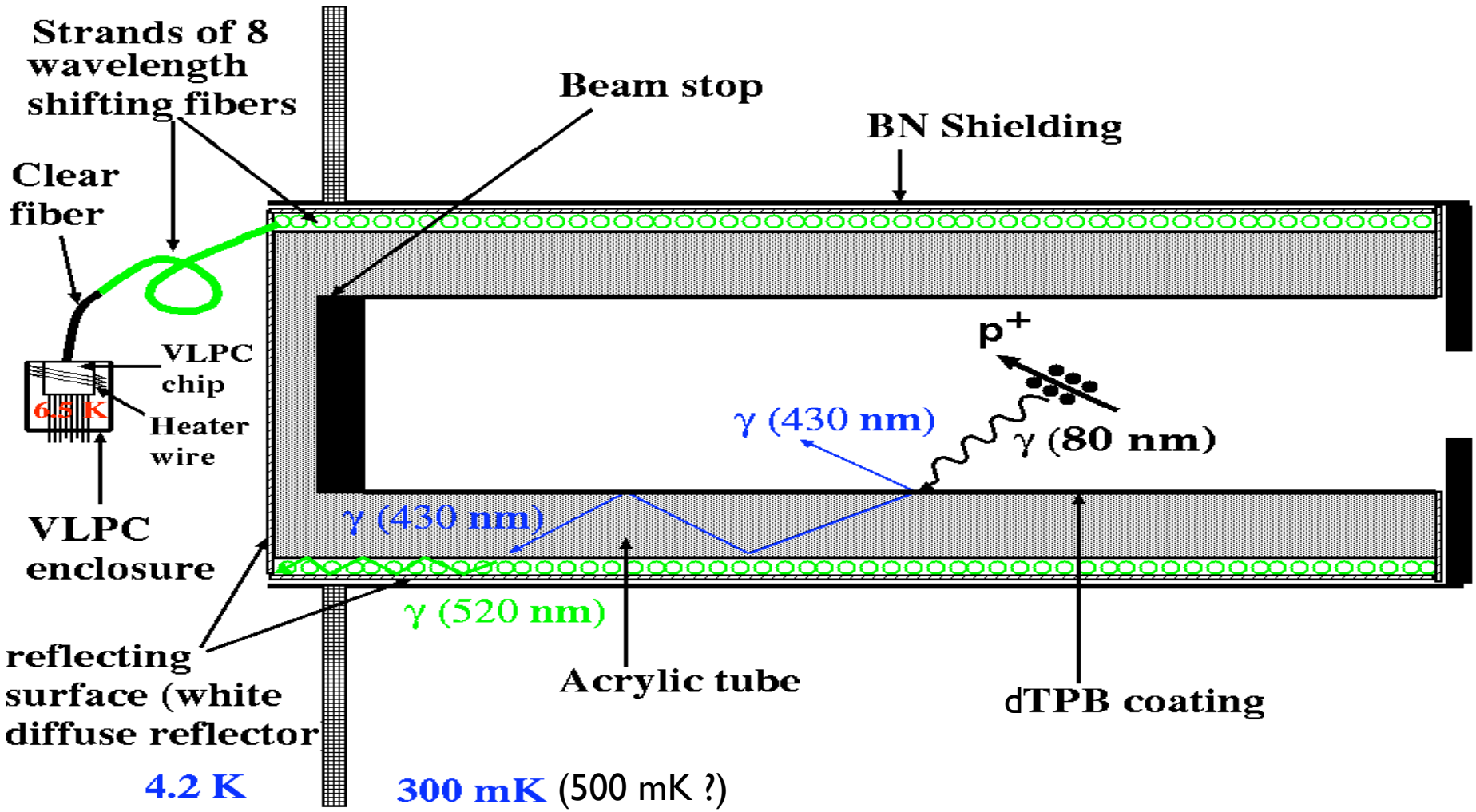
Current Cell Design



Current design for light transport

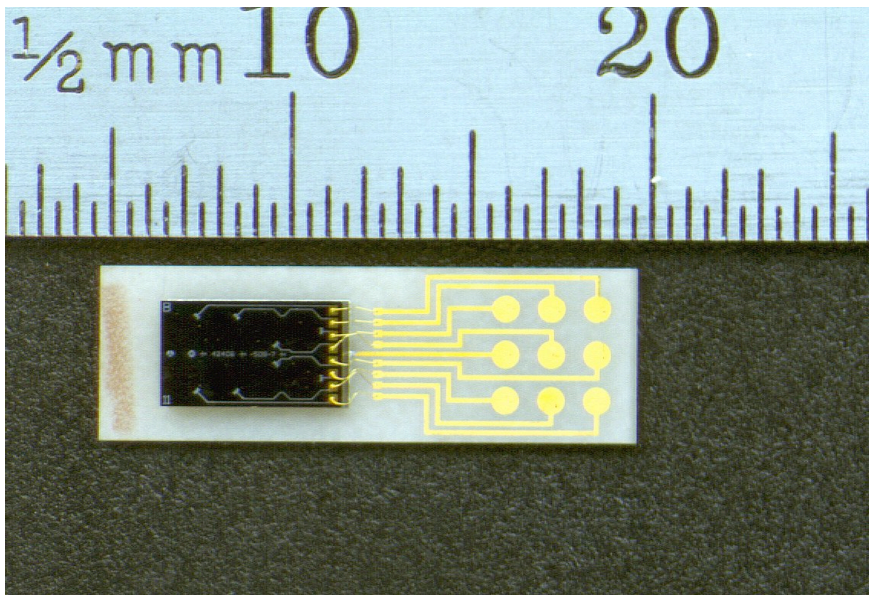


Alternative (possible) Cell Design



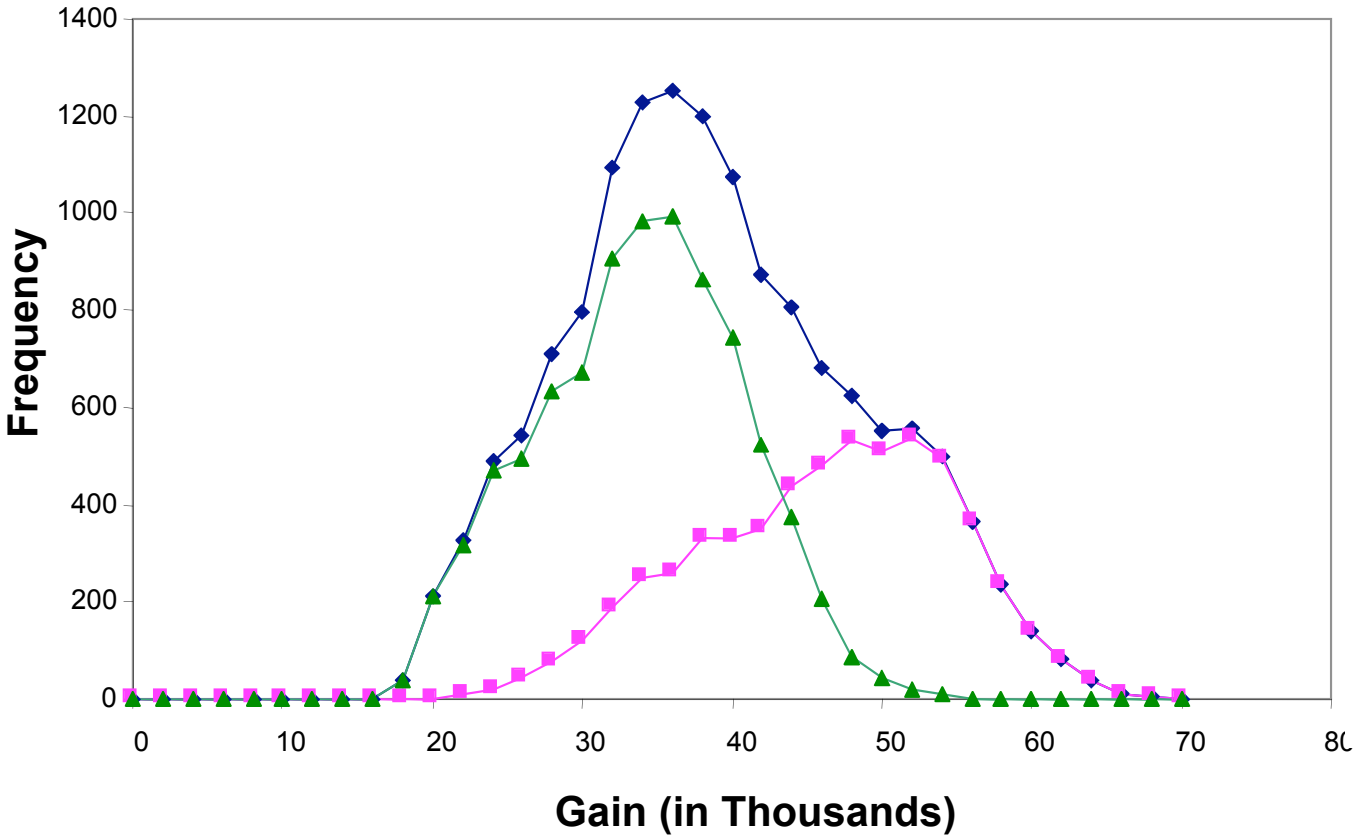
Visible Light Photon Counters

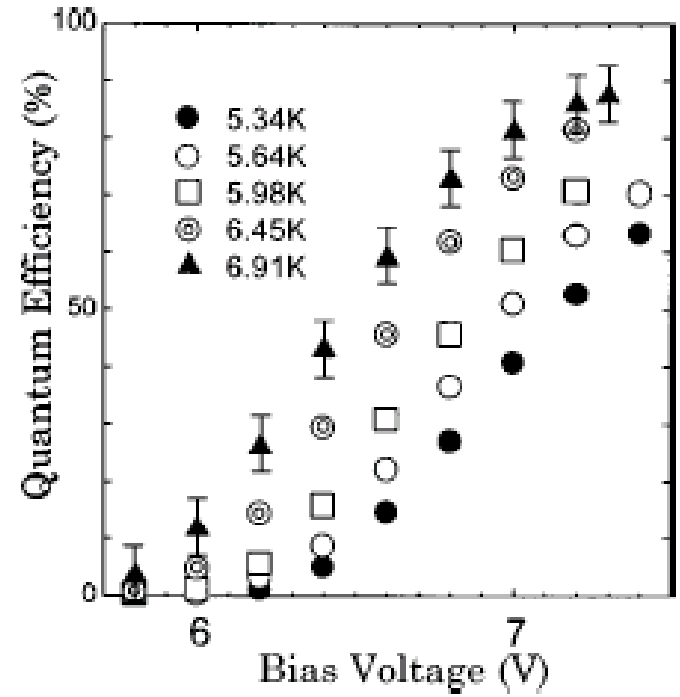
VLPC's are arsenic doped silicon diodes, designed to convert single photons into many thousands of electrons with high quantum efficiency.



-Detects single photons
-Operate at a few degrees Kelvin
-Quantum efficiency ~80%
-Insensitive to magnetic fields
-High gain ~40 000 electrons per converted photon

VLPC Characteristics





S. Takeuchi et al., Appl. Phys. Lett, 74, 1063 (1999)

Pros & Cons

- Shorter pathlength from cell to detector

  No breaks in the light guide.

  Lower light backgrounds.

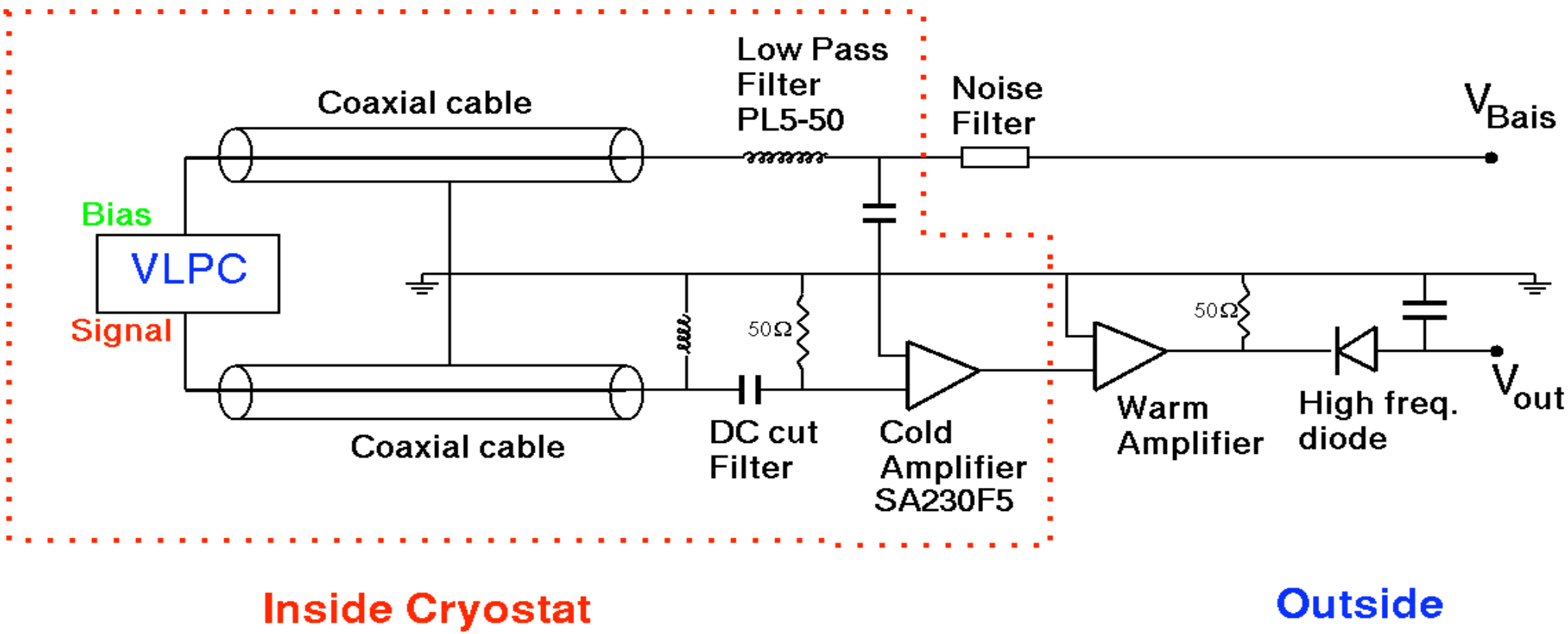
- Light collected in the cell might be less.

Previous Experience

- VLPCs have been extensively used in Scintillating Fiber Trackers at Fermilab.
- Used for single photon detection.
- The Doyle group attempted to test their wavelength shifting fiber based detector using VLPCs. They borrowed the VLPC and readout circuit from Fermilab. But the readout system turned out to be too noisy.

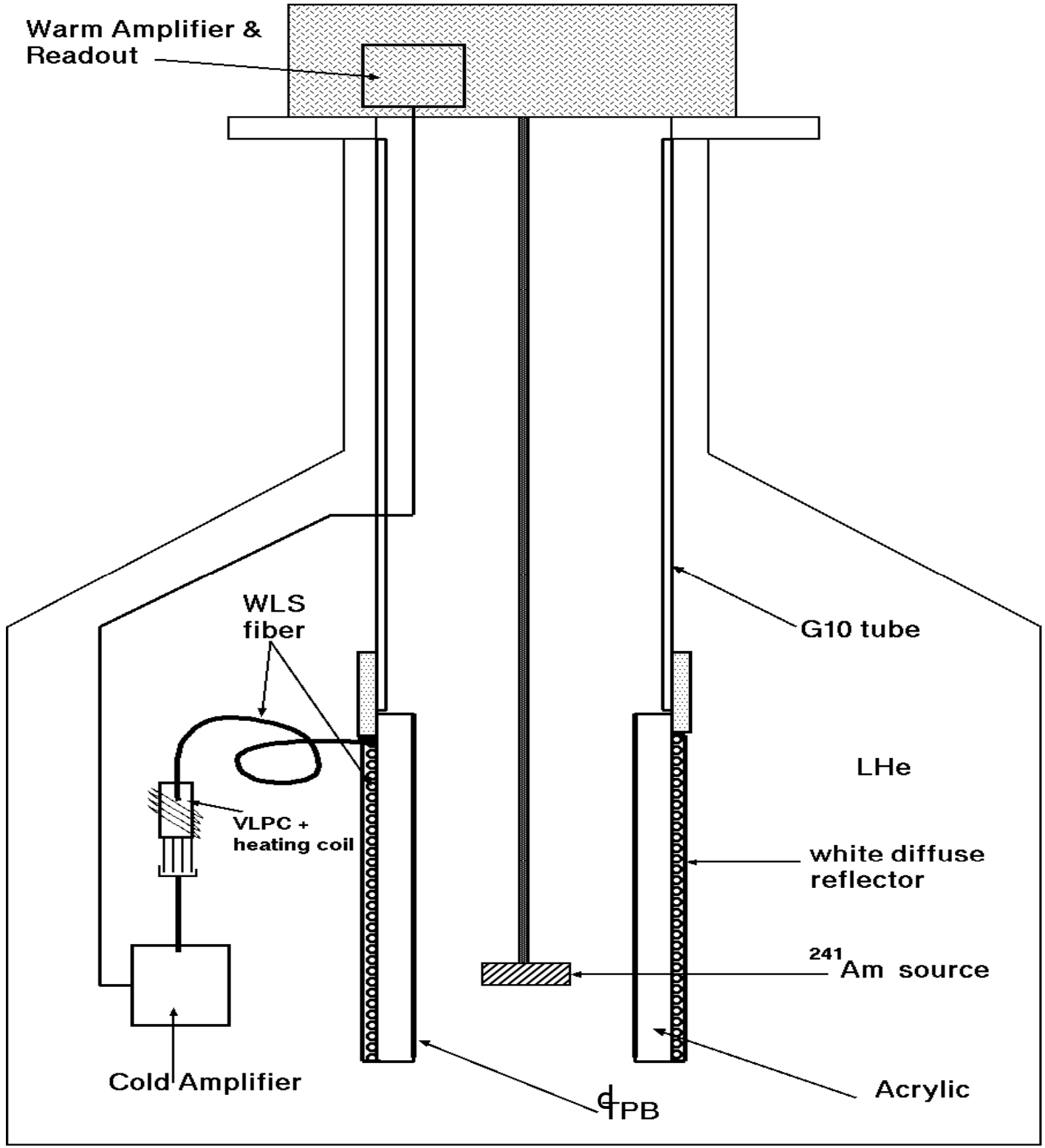
New Readout Method

Use a ultra low-noise amplification scheme developed for single photon counting experiments.

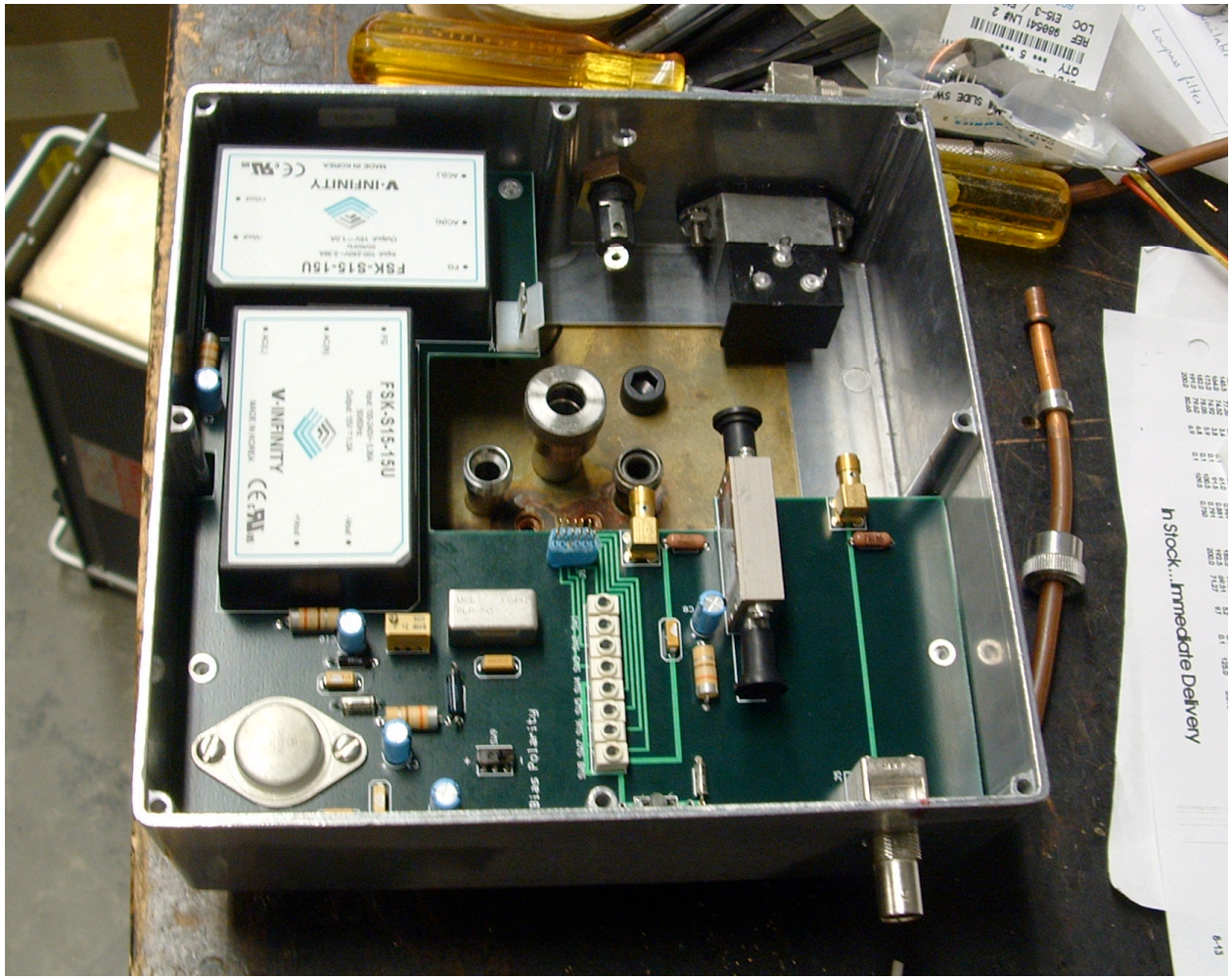


J. Kim et al., Appl. Phys. Lett, 70, 2852 (1997)
S. Takeuchi et al., Appl. Phys. Lett, 74, 1063 (1999)

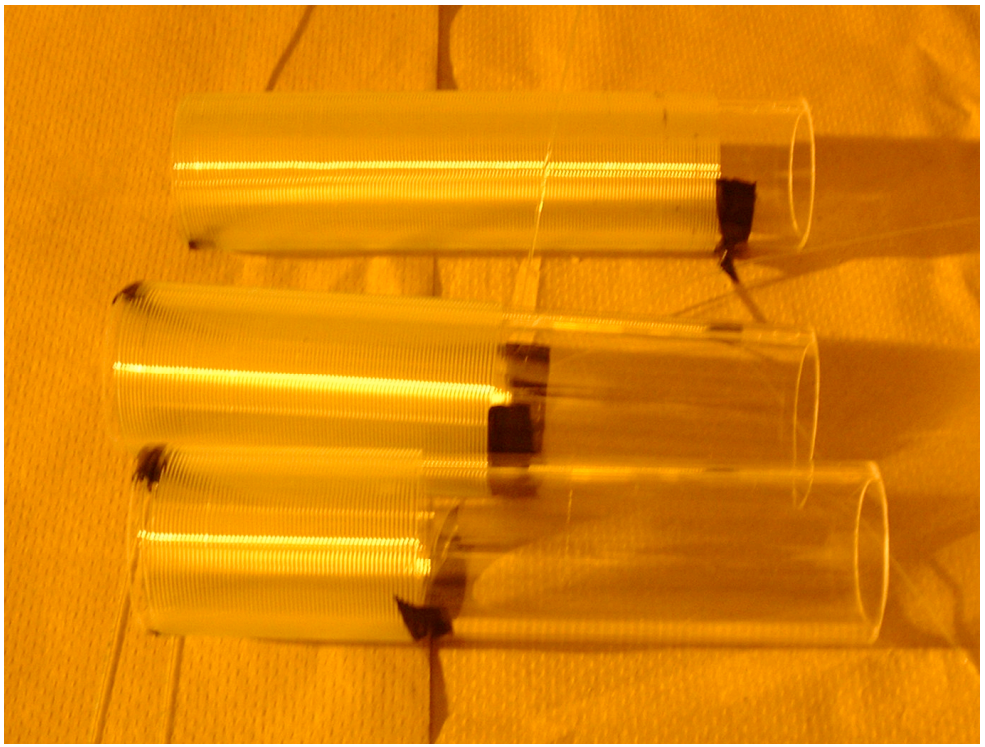
Test Setup at Duke

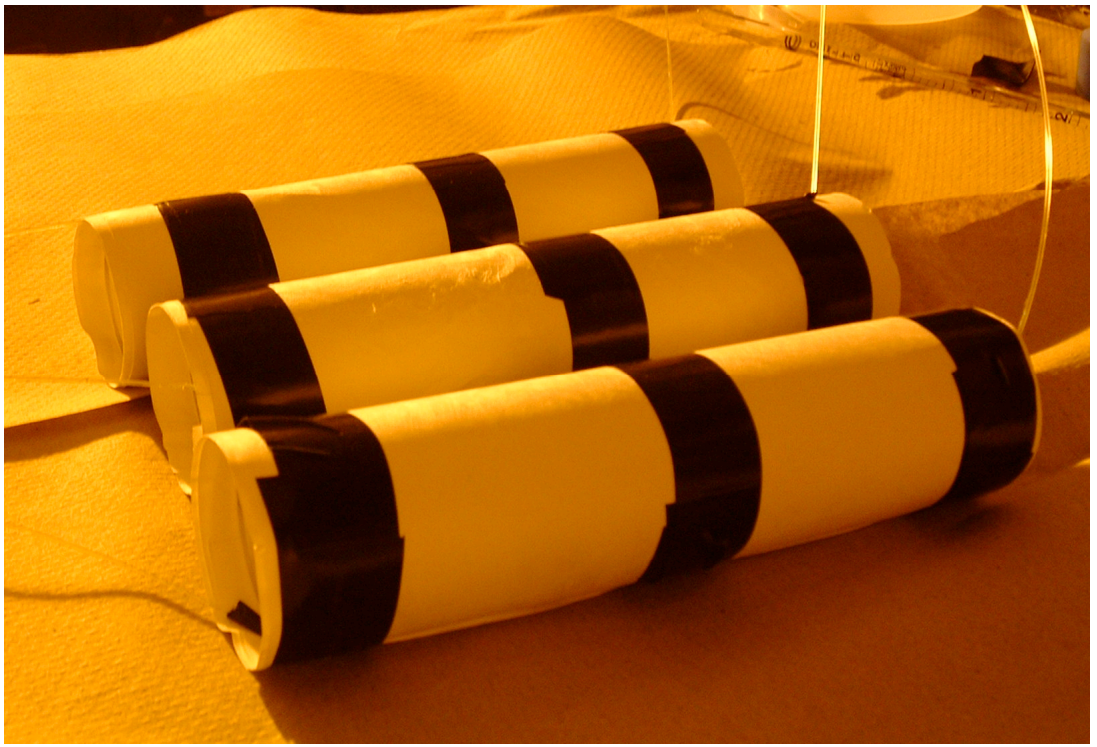


Warm amplifier and VLPC bias



Test Cells

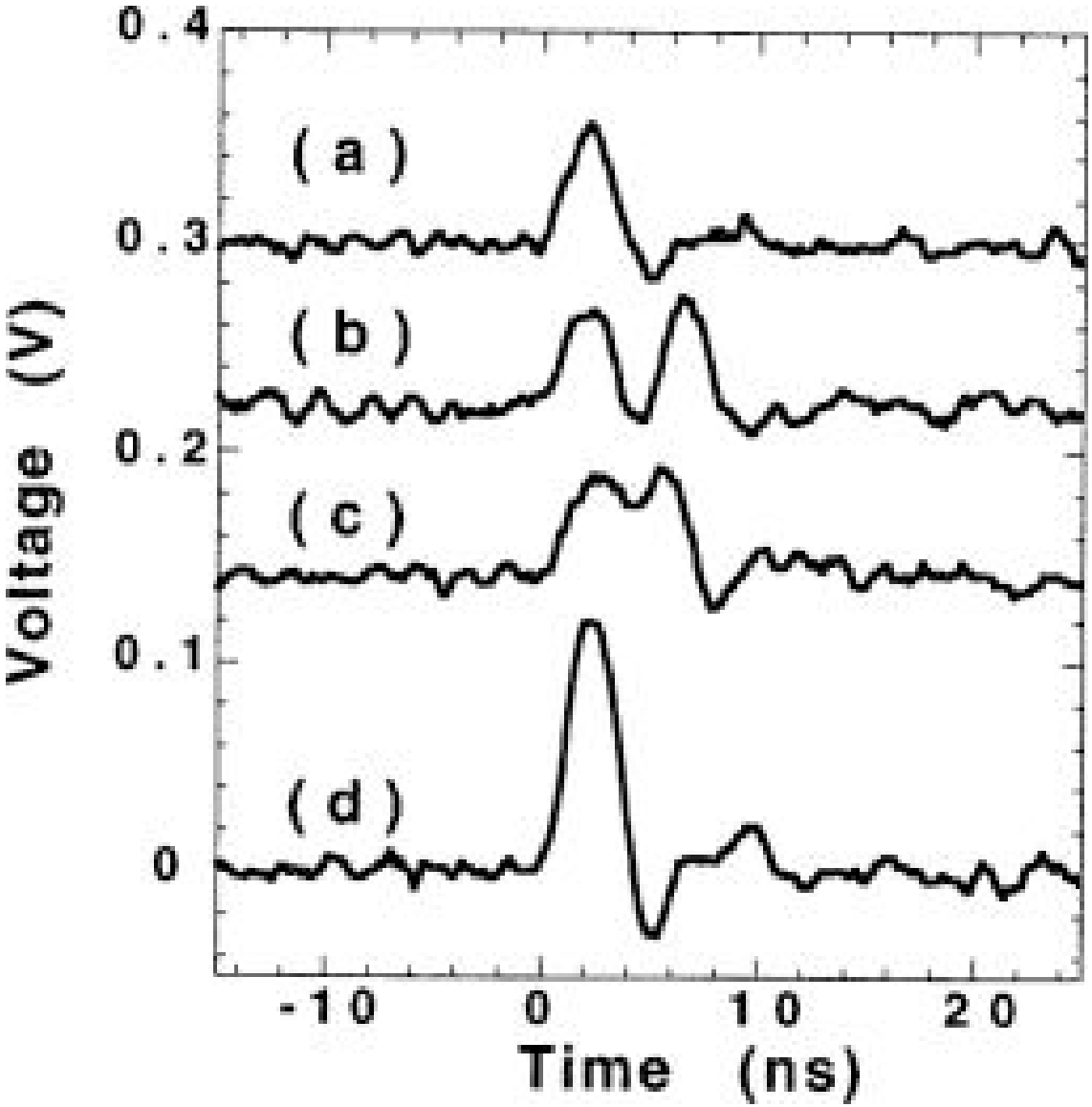




Status of the Duke VLPC project

- The previous setup was built and the experiment was run. Temperature of 6-7 K (necessary for VLPC operation) was achieved successfully. No signal detected.
- Originally, the VLPC signal went out of the cryostat and then back in to become amplified. Signal probably lost along the way.
- Jungsang Kim in the Engineering Department has a similar set up and was able to detect dark counts using one of our VLPCs.
- We took cell and radioactive source out to see if it was possible to just detect dark counts with the VLPC.

VLPC Output



(a) Single photon detection.
(b) 5 ns delay.
(c) 3 ns delay.
(d) zero delay.

J. Kim et al., Nonclassical Light from Semiconductor Lasers and LEDs

- The NFE amplifier was replaced with the amplifier J. Kim successfully used in his experiment (Agilent MGA-8156).
- One of the VLPC channel outputs was connected directly to the amplifier inside the cryostat.
- Experiment was run but too much noise detected, impossible to see the signal.
- Went to seek more advice from J. Kim's lab. Before trying to measure a signal they look at the output in the spectrum analyzer and use appropriate filters to get rid of most noise. This is our next step.
- Once we are able to detect dark counts we will proceed with the test cell and radioactive source.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